CLAIMS

Therefore, at least the following is claimed:

1 1. A digital subscriber line (DSL) transceiver, comprising:

2 a pulse amplitude modulation (PAM) transmitter;

3 a fractional encoder associated with the PAM transmitter, the fractional encoder

4 configured to encode a non-integer number of bits for each word to be transmitted by

5 the PAM transmitter; and

6 a constellation encoder configured to encode each word containing the non-

7 integer number of bits into a signal space constellation to be transmitted by the PAM

8 transmitter, and where each signal space constellation comprises a symbol.

1 2. The transceiver of claim 1, wherein the signal space constellation is

2 generated by the PAM transmitter.

1 3. The transceiver of claim 1, wherein the fractional encoder further

2 comprises a modulus converter.

1 4. The transceiver of claim 1, wherein the fractional encoder further

2 comprises a shell mapper.

1 5. The transceiver of claim 1, wherein the fractional encoder further

2 comprises a constellation switcher.

1   6.   The transceiver of claim 1, wherein each symbol is transmitted using a

2   single dimensional signal space constellation.

1   7.   The transceiver of claim 1, wherein each symbol is transmitted using a

2   multi-dimensional signal space constellation.

1   8.   The transceiver of claim 1, further comprising a trellis encoder associated

2   with the constellation encoder.

1   9.   The transceiver of claim 1, wherein the fractional encoder is configured

2   to collect an integer number of bits $S*K$, over a frame comprising several symbol

3   periods S, and is configured to encode the frame of $S*K$ bits for transmission at a

4   fractional bit rate of K bits per symbol.

1   10.   The transceiver of claim 9, wherein the fractional encoder is configured

2   to convert the $S*K$ bits of the frame into S integers, each of arithmetic base M, where M

3   corresponds to a plurality of PAM signal levels.

1   11.   The transceiver of claim 1, further comprising a fractional decoder

2   configured to decode a received symbol into a non-integer number of bits.

1   12.   The transceiver of claim 11, wherein the fractional decoder is a modulus

2   converter.

1   13.   A method for encoding fractional bit rates using pulse amplitude

2   modulation (PAM), the method comprising the steps of:

3   providing a PAM modulator;

4   using the PAM modulator to generate a transmit signal; and

5   encoding the transmit signal with a modulation symbol representing a non-

6   integer number of bits, wherein the sum of the bits over a plurality of symbol times

7   results in an integer number of bits.

1   14.   The method of claim 13, wherein the encoding step includes modulus

2   conversion.

1   15.   The method of claim 13, wherein the encoding step includes shell

2   mapping.

1   16.   The method of claim 13, wherein the encoding step includes constellation

2   switching.

1   17.   The method of claim 13, wherein the modulation symbol is encoded into

2   a multi-dimensional signal space constellation.

1   18.   The method of claim 13, wherein the modulation symbol is encoded into

2   a single dimensional signal space constellation.

1   19.   The method of claim 13, further comprising the step of trellis encoding

2   the modulation symbol.

1   20.   The method of claim 13, further comprising the steps of:

2   collecting an integer number of bits S*K, over a frame comprising several

3   symbol periods S; and

4   encoding the frame of S*K bits for transmission at a fractional bit rate of K bits

5   per symbol.

1   21.   The method of claim 20, further comprising the step of converting the

2   S*K bits of the frame into S integers, each of arithmetic base M, where M corresponds

3   to a plurality of PAM signal levels.

1   22.   A digital subscriber line (DSL) transceiver, comprising:

2   means for providing a PAM modulator;

3   means for using the PAM modulator to generate a transmit signal, the transmit

4   signal including a plurality of transmit symbols; and

5   means for encoding each of the transmit symbols with a non-integer number of

6   bits, wherein the sum of the bits over a plurality of transmit symbols results in an integer

7   number of bits.

1   23.   The transceiver of claim 22, wherein the encoding means includes

2   modulus conversion means.

1   24.   The transceiver of claim 22, wherein the encoding means includes shell

2   mapping means.

1   25.   The transceiver of claim 22, wherein the encoding means includes

2   constellation switching means.

1   26.   The transceiver of claim 22, wherein the transmit symbol is encoded into

2   a single dimensional signal space constellation.

1   27.   The transceiver of claim 22, wherein the transmit symbol is encoded into

2   a multi-dimensional signal space constellation.

1   28.   The transceiver of claim 22, further comprising means for trellis encoding

2   each of the transmit symbols.

1   29.   The transceiver of claim 22, further comprising:

2   means for collecting an integer number of bits $S*K$, over a frame comprising

3   several symbol periods S; and

4   means for encoding the frame of $S*K$ bits for transmission at a fractional bit rate

5   of K bits per symbol.

1   30.   The transceiver of claim 29, further comprising:

2   means for converting the $S*K$ bits of the frame into S integers, each of

3   arithmetic base M, where M corresponds to a plurality of PAM signal levels.